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DIFFICULTIES IN THE DESIGNING AND OPERATION OF MEDIUM SIZED WATER WORKS PLANTS

BY E. B. BLACK

In the early history of the development of the business of furnishing cities with an adequate supply of pure and wholesome water, the cost of such service was necessarily large, as is to be expected in the development of any commercial enterprise, so only those cities of sufficient size, or of such peculiar location that a fair return seemed possible on a considerable investment, could interest private capital in the building of water works systems.

The demand for the many advantages a modern water system brings a city comes as a result of education. Gradually the small cities and towns began to demand such improvements, and when private capital could not be interested on account of the limited revenue possible from a small community, special legislation allowed the building of systems by these small cities themselves. It seems now that a town of from 1000 to 5000 inhabitants can build a water works system, in some sections of the country at least, with as little trouble in financing the proposition as was formerly experienced in towns of 50,000 or 100,000.

Perhaps no other state has made possible the building of public utilities in the same way that Kansas has. With an allowable indebtedness of 15 per cent of the assessed valuation, and with the assessed valuation taken as the full value of property, it has been an easy matter to vote bonds for the purchase of existing systems or the building of new ones. Three years ago an emergency law was enacted by the state which allowed all cities and towns already owning their water works systems to issue bonds for necessary improvements until the total indebtedness of the municipality should reach 15 per cent. These bonds may be issued without vote of the people, the only requirement of the law being the approval of detailed plans, specifications and estimates of cost by the State Utilities Board prior to the issuance of the bonds.

All these things have worked together to stimulate the building

of new systems in the small cities and towns of Kansas, and the building of needed improvements in those towns already owning their systems, until now there is a total of about two hundred and fifteen water systems in the state, and about 90 per cent of the total number are in towns ranging from 500 to 4000 inhabitants. It may be of interest also to note that not more than a dozen of these systems are privately owned. While conditions in Kansas may have been more favorable than elsewhere in the past for the building of small water systems, such improvements have by no means been confined to that state, and the small cities and towns throughout the country, realizing the benefits coming from the establishment of such systems, have been actively shaping legislation so they also may have water systems.

The design and operation of systems in towns of small size present difficulties foreign to the design and operation of large plants. In designing, the services of an engineer are often dispensed with, and practically never is an engineer retained to advise relative to the operation of the system. This may be on account of the size of the proposition and the desire to put every dollar available into the improvement. Then again, the design may be handled by a concern manufacturing or selling equipment. Admitting the fact that such concerns may have the best engineering talent available, it is not reasonable to assume that other concerns will feel free to bid on their competitor's design; or that the proposal of the designer, if accepted without competition, will be either an efficient or economical one. Many small systems have been built by the contracting engineer. The design and the construction both frequently suffer in such cases. It is difficult for a man to design a system, bid on it with other bidders, and then construct under his own plans, specifications and supervision.

In some systems the poor ideas of the owner or city officials are followed; this is sometimes the case even when an engineer is retained. In going over a sewage disposal proposition recently, plans of the city's sewers were furnished. The engineer who had planned the sewers had evidently suffered from suggestions of various officials; for on one sheet of the profiles was this note,

The number and location of Wye branches and manholes on this sewer were fixed by the city clerk and the plan does not therefore represent my ideas in the matter. Please refer to my letter of _____ date in this connection.

A short time ago a city retained engineers to design a storage reservoir to be used in connection with one already in use. The bottoms of both reservoirs were to be on the same elevation only a few feet from wall to wall, and the water was to be carried in both at the same levels. The superintendent asked that a syphon be used to get the water from one reservoir to the other. He had never built a syphon, here was his opportunity. This reason is probably responsible for more mistakes in construction than any other.

Some of you are familiar with a plant in which the discharge line from the pumps is carried up the outside and over the top of the standpipe supplying the town. This is a scheme evolved by one of the plant engineers, which enables the pumps to operate against a column of water only ten inches in diameter instead of one thirty feet in diameter, the size of the standpipe. You may have heard of the gravity flow line, the size of which was increased by sections from the upper to the lower end in order to overcome friction.

Some years ago the writer made an appraisal of a privately owned power plant for a town contemplating its purchase. The plant originally consisted of a generator, clutch connected to a line shaft driven by a water wheel. The time came when the water power was insufficient, so the line shaft was extended and two large gasoline engines belted to it from a single clutch pulley between them; so connected that either or both engines could help the waterwheel. But even then the power was insufficient at times, and at the time the plant was examined a traction engine was belted to the line shaft through a hole in the wall of the power house. The owner was even then looking for more power, and wondering why the plant did not operate satisfactorily. Some one had advised him that all well regulated plants kept records of ammeter and voltmeter readings. These had therefore been faithfully recorded each thirty minutes of the plant's operation; but the current generated was three phase and the readings had been taken from one ammeter and one voltmeter connected to one phase only.

These instances are not exceptions in the average small plant; indeed, many more serious mistakes are known to every plant operator. Water systems with no water supply, filtration plants that fail to filter, and many other such mistakes are matters of common knowledge. Practically all of these things can be traced back to a desire to save a few dollars of the original investment, at the

expense of comparatively greater cost of operation and maintenance. Even in the power plant, that part of the system where efficiency might be expected, and in plants where tests are made on the equipment at the time of its installation, provision is seldom made so the superintendent can run an overall efficiency test at any time, and the guaranteed efficiencies under which simple equipment is often purchased are frequently impossible of determination by the superintendent, after the plant has been turned over to him. Power plants are installed with separate guarantees on engines, boilers and generators; motor driven pumps with separate guarantees on motors and pumps. In the small plant and in many large ones, an "overall" efficiency guarantee is possible, and it is the only guarantee for which the superintendent has a great deal of use.

Efficient equipment in a plant counts for little unless you know that that equipment is maintaining its efficiency through efficient operation.

The man never lived who thoroughly enjoyed writing reports and weighing coal, or even changing record cards on recording instruments, but no plant can operate successfully and economically without an accurate and detailed record of its operation. In the small plant, recording instruments and labor saving devices, or even proper valves and meters are sometimes entirely lacking. How can an operator know what his plant is doing when he only knows how much coal he uses and how much money he takes in each month? Nearly all owners object to the size of the coal bill or to the amount paid out for chemicals for the filtration plant, but very few offer their superintendents expert assistance in cutting down the size of these bills. Business management does not entirely consist in keeping the operating cost within the receipts.

Two years ago the writer visited a privately owned water works plant, and inquired of the engineer in charge how much alum he was using, and how often he analyzed the water. His answer was that he used from three to six grains and that in the two years he had been connected with the plant no analyses had been made.

Perhaps one of the hardest problems for satisfactory solution from the standpoint of results, is the operation of filtration plants of small size, for practically every plant of 5,000,000 gallons or less per day has to be operated intermittently, thus presenting added difficulties over the operation of a large plant. Obviously more attention should be given to the design and operation of such plants.

It is certainly of prime importance that this phase of the question should be given study it has not been given in the past.

The large water works system is not the only one entitled to efficient operation, to dividends and to the enthusiastic support of its patrons. Perhaps the system using the extra line to the top of the standpipe had other much more serious defects in its construction, and with these corrected, it might have operated at a profit instead of a loss. In all probability the owner of the system, the superintendent of which increased the size of the lower sections of the flow line to avoid friction, wondered why his investment was greater than necessary to accomplish a given result. The owner of the filtration plant where no analyses had been made for at least two years probably considered himself abused when patrons objected to the quality of water furnished.

There are good and sufficient reasons for about ninety-nine per cent of the defects of design and operation of the small water works system, and the successful owner or operator is the one who removes these defects by careful and intelligent design and operation. There is little real excuse today for poor design or unintelligent operation of the small sized water works systems. The various state boards of health have done, and are doing, a remarkably efficient work in the education of the owners and operators of plants from these standpoints, and associations such as the American Water Works Association, through publications and conventions, make it possible for every water works superintendent to get ideas adaptable to the proper solution of the problems of his own plant, and surely no engineer, owner, or superintendent is worthy of his position who fails in demanding the best design and best results of operation for the small as well as for the large system.